**CLIMATE CHANGE** 

# The Greening of Insurance

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legraphs climate risks to its insurers. In turn, climate change stands as a stress test for insurance, the world's largest industry, with U.S. \$4.6 trillion in revenues, 7% of the global economy (1-6). Insurers publicly voiced concern about human-induced climate change four decades ago (1). I describe industry trends, activities, and promising avenues for future effort, from a synthesis of industry progress in managing climate change risk [see supplementary materials (SM)].

Increasingly, multifaceted weather- and climate-related insurance losses involve property damage, business disruptions, health impacts, and legal claims against polluters. Worldwide, insured claims that were paid for weather catastrophes average \$50 billion/year (about 40% of total direct insured and uninsured costs); they have more than doubled each decade since the 1980s, adjusted for inflation (7, 8). Insurers must also adjust to risks emerging from society's responses to climate change, including how structures are built and energy is produced.

Where there are risks, there are also opportunities. Responding to the push of shareholders and regulators and the pull of markets, a trio of global initiatives [United Nations Environment Programme Finance Initiative (1995), ClimateWise (2007), and the Kyoto Statement (2009)] has aggregated 129 insurance firms from 29 countries (table S1). Member commitments include supporting climate research, developing climate-responsive products and services, raising awareness of climate change, reducing in-house emissions, quantifying and disclosing climate risks, incorporating climate change into investment decisions, and engaging in public policy. Since the mid-1990s (3), these and many other insurers, reinsurers, intermediaries, brokers, industry associations, catastrophe-loss modelers, and regulators have engaged in this work (see the figure) (fig. S1, A to C), often in partnership with universities, development agencies, nongovernmental organizations, foundations, think tanks, and governments (9). These increasingly sophisticated efforts were sustained through the economic malaise of the past few years; one-fifth of the activities identified in the figure began after 2008.

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#### Climate Science, Adaptation, and Mitigation

As past experience is an ineffective predictor of future losses, many insurers are using climate science to better quantify and diversify their exposure, more accurately price and communicate risk, and target adaptation and loss-prevention efforts (table S2). Insurers also analyze their extensive databases of historical weather- and climate-related losses, for both large- and small-scale events (7-11). Insurers from North America, Asia, and Europe have expanded their collaborations through the three latest Intergovernmental Panel on Climate Change assessments into projects such as harmonizing economics-based insurer catastrophe models with climate models. Insurers' models extrapolate historical data rather than simulate the climate system, and they require outputs at finer scales and shorter time frames than climate models.

Insurers can reactively adapt to rising losses by tightening availability, prices, and terms. Instead, some have sought to help vulnerable customers improve their resilience to a changing climate. Strategies include financial and physical risk management, often in collaboration with noninsurance entities (table S3). Insurers have championed a broadened definition of sustainability that includes resilience to disaster and a low carbon footprint. Beyond signaling that lossprone development is unsustainable, insurers are supporting interventions with benefits for both emissions reduction and adaptation (table S4 and fig. S2). Integrated actuarial and environmental science is enhancing adaptive capacity to climate change in the developing world, where poor populations enjoy little access to insurance. Decades ago, public and nonprofit sectors offered microinsurance (small premiums for modest coverage), with commercial insurers later adding tens of millions of policies for life, health, and property (table S5). Some employ parametric and index-based triggers for climatesensitive crops and livestock by using remote sensing. Others promote adaptation, e.g., improved soil management.

Numerous insurers aim to curb greenhouse-gas emissions from homes, businesses, transport, industry, and agriculture (table S5). They have brought to market at least 130 products and services for green buildings. Many pay claims that fund rebuilding to a Insurance industry trends show how market-based mechanisms support climate change mitigation and adaptation.

higher level of energy efficiency after losses. Insurers have introduced at least 65 offerings for renewable energy systems.

Some climate-change mitigation technologies align with lower-risk behavior. Nearly 3 million pay-as-you-drive policyholders enjoy more accurate roadway accident premiums using telematics to verify distances driven. This price signal could reduce U.S. driving by 8%, worth \$50 to \$60 billion/year, thanks to reduced congestion and lower probability of accidents, while reducing cross-subsidies from those who drive less than average to those who drive more (12). Risk-based premium credits are also offered for low-emissions vehicles and green buildings (table S5).

Other products insure financial shortfalls if energy savings or low-emissions power generation projects underperform or manage risks in carbon-trading transactions, ranging from carbon release from wildfires to infrastructure appropriation by foreign governments. Insurance strategies assuming these risks and minimizing losses align with the broader policy objectives of verifiable, bankable, and persistent emissions reductions.

#### Technology, Governance, and Policy

When risks are too great or undefined, insurers withdraw coverage or increase prices. Climate change mitigation and adaptation present dual challenges in this regard: unintended risks (e.g., nuclear power and weapons proliferation) and climate vulnerabilities (e.g., biofuels and water needs) (tables S6 and S7). Insurers abhor unquantified and unpriced risks, as well as market distortions, such as equally subsidizing technologies that have divergent risk profiles (13).

Emerging technologies lack the operational history desired for underwriting. The most unwieldy of these are "climate-engineering" techniques, ranging from carbon capture and storage (CCS) to artificially modifying the radiative properties of the atmosphere. Insurers have entered the CCS market in a circumscribed manner, excluding riskier strategies or financial arrangements, limiting coverage to short time frames, and ceding long-tail risks to the public sector. Conversely, energy efficiency is arguably the lowest-risk mitigation strategy (followed by renewables), with abundant benefits (14). Societal dithering forces reliance on approaches that are riskier and less amenable to insurance underwriting.

Insurers are dually exposed to internal governance risks (e.g., underestimating climate-related losses) and those taken by their customers (e.g., polluters). More than one in four corporate directors anticipate liability claims stemming from climate change (15). Litigation often requires insurers to furnish legal defense and to pay damages. Insurers have responded with new liability products and by excluding climate-change claims where customer behaviors are unduly risky. Insurance regulators and investors are seeking climate-risk disclosure (table S8 and fig. S3), compelling insurers to for-

mally consider climate change in operational, business, and investment practices. Liability risks are rising as climate science becomes more settled.

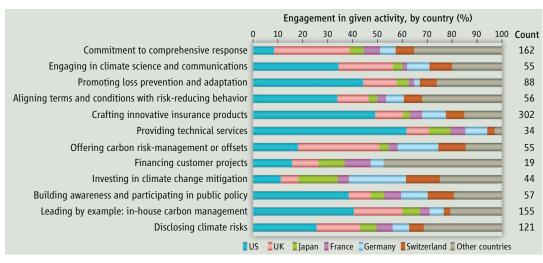
With \$25 trillion in assets—equal to global mutual funds or pension funds—insurers are central players in world financial markets. They have invested at least \$23 billion in emissions-reduction technologies, securities, and financing, plus \$5 billion environmentally focused funds (table S9 and fig. S4).

Emissions from insurers' energy-intensive buildings, data centers, and business travel are 12 megatons CO2/year with a 10-fold variation in carbon intensity (per unit of revenue) across companies (9). Scores of insurers have reduced their emissions, with at least 26 carbon neutral (table S10 and fig S5).

Insurers have influenced public policy, striking agreements on pricing risk and government's role in risk management and shaping land-use planning and energy policy in many countries. They have engaged in climate policy forums since the mid-1990s (2, 3), including participation in the international climate negotiation process. Lloyds of London is one of the more prominent; they view climate change as the industry's number-one issue (5). Insurers are uneasy with mercurial policies on natural hazards and energy. Shifts in public incentives or indemnity practices can adversely influence risk-taking (moral hazard), heightening insurers' exposures.

#### From Risk to Opportunity

Climate-focused efforts have benefitted millions of insurance customers and have mobilized billions of investment dollars, although public and policy-maker engagement in these



Global insurance industry engagement in climate change adaptation and mitigation activities. As of late 2012, a total of 1148 initiatives have emerged (largely in the past decade) from 378 entities in 51 countries, representing \$2 trillion (44%) of industry revenues. Count represents number of activities in each category. Details in SM.

efforts remains low. Little climate-related innovation has occurred in certain market segments, e.g., life and health (microinsurance being an exception), maritime, aviation, and heavy industries. Greater scale is needed if the insurance industry is to realize its potential.

Independent auditors found an 88% compliance rate among signatories of the Climate-Wise principles (table S1) (16). Yet, many companies remain on the sidelines or offer only token gestures, perhaps because of insufficient demand, ideological discomfort with policy responses, inadequate science literacy, or inertia to institutional change. Insurers face external barriers as well. Some regulators and consumer groups resist risk-based pricing and insurer innovations (17).

It is argued by some that private insurers have not effectively advanced climate change mitigation and adaptation and that the risks may even become uninsurable (18). Mandatory climate-risk disclosure identified a broad consensus on the relevance of climate change among U.S. insurers, but only one in eight companies have a formal strategy.

Public insurers could be similarly criticized (19). As insurer of last resort (e.g., \$1.3 trillion coverage for flood and \$115 billion for crops in the United States), they could learn from their private counterparts. Governments could boost demand for market-based "green insurance" by using it in their own operations.

Promising scientific frontiers include loss modeling under future climates, preferably on a public-domain platform, to yield better economic assessments and policy pathways. Lacking are comparative risk-assessments of climate-change response options to inform research and development and policy needs and to determine their insurability.

The insurance sector is a global clearinghouse for climate risks that affect every underwriting area and investment. Where insurers recoil in the face of climate change, consumers will encounter acute affordability issues accompanied by huge holes in this societal safety net. But insurers' efforts to date demonstrate that market-based mechanisms can support greenhouse-gas emission reductions and adaptation to otherwise unavoidable impacts.

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#### **Supplementary Materials**

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# Supplementary Materials for

# The Greening of Insurance

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Materials and Methods Figs. S1 to S5 Tables S1 to S10 Full References

#### **Materials and Methods**

This analysis groups insurer climate-change activities into 12 broad categories (Fig. 1 and fig. S1, A to C). Figure S2 illustrates climate change adaptation efforts with mitigation synergisms. Time-trend analysis is possible in some cases, as illustrated here for carbon risk disclosure (fig. S3), insurer investments in climate change mitigation (fig. S4), and pursuit of carbon neutrality for internal operations (buildings, business travel, business operations, etc.) (fig. S5).

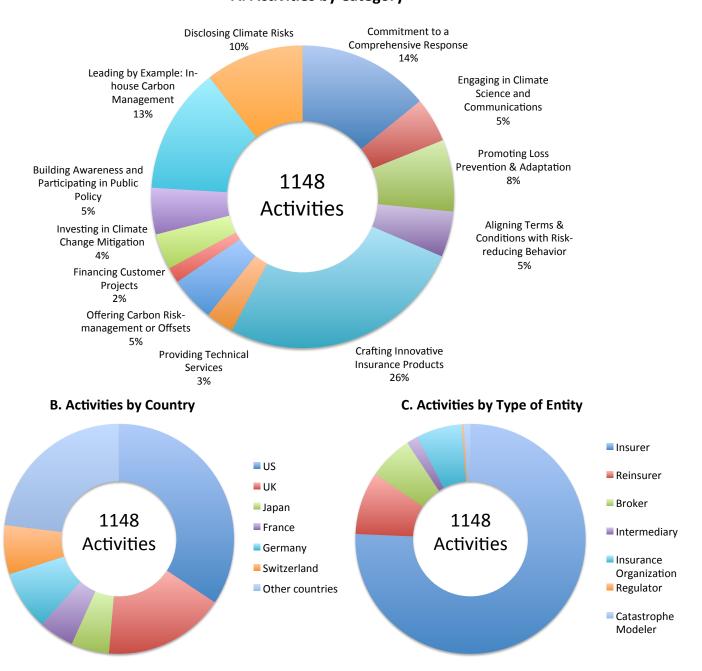
The tabulated examples (tables S1 to 10) reflect the breadth of insurer-initiated approaches to improving disaster resilience and adaptation to climate change, while further reducing the risks through mitigation strategies such as buildings' energy efficiency, low-emissions transportation, carbon emissions trading, and investments in renewable energy projects. The magnitude of progress or market uptake is quantified where information is available.

The information is compiled from a variety of primary sources: company Web sites, corporate social responsibility reports, filings with the Carbon Disclosure Project (CDP), insurance trade press, academic journals, technical reports, and direct communications with insurers. Initiatives that aggregate information from member insurers [e.g., ClimateWise (16) and the United Nations Environment Programme (UNEP) Finance Initiative] are also reviewed. Most available information is self-reported by insurers, and in some cases independently verified (e.g., PricewaterhouseCoopers audits the annual ClimateWise reports). Many items are readily verifiable, e.g., whether or not a company responded to the CDP, is a signatory to a particular agreement, offers a particular green insurance product, or has conducted and published specific research.

Various decision rules are applied before including candidate activities. Multiple activities of a similar nature are counted only once (e.g., responding to a given annual call for climate-risk disclosure, multiple efforts at reducing in-house greenhouse gas emissions, multiple years of corporate social responsibility reporting, or more than one subsidiary through which products or services are offered). Routine activities, such as rationalizing pricing, shifting to paperless customer correspondence, holding workshops, encouraging generic disaster preparedness, offering weather derivatives, or providing conventional insurance of renewable energy systems (which many insurers have done for decades), are not tabulated here as they are mainstream or intangible activities, or are not primarily motivated by responding to climate change risks. Similarly, "passive" activities such as memberships in organizations (e.g., the U.S. Green Buildings Council) are not logged. Also excluded are activities (i) with a tenuous "green" value, e.g., insurers promoting global positioning systems (GPSs) in autos but not accompanying it with – premiums differentiated by distance driven (12), or (ii) where companies appear to be bundling or repackaging conventional offerings, rather than truly innovating to fill coverage gaps or carefully tailoring coverage to the unique features of "green" technologies. Mandatory and prospective activities are not included.

These tallies are neither a measure of the relative quality nor the impact of the activities, or of geographical reach. No weighting is applied. Although sampling bias cannot be ruled out, every effort has been made to gather information from around the world and from all sizes and types of insurance entities.

# Structure of Insurer Climate-change Risk Management Activities A. Activities by Category



**Fig. S1.** As of October 2012, 378 insurance entities based in 51 countries had collectively initiated 1,148 activities related to managing the risks of human-induced climate change (9, plus updates). These activities have emerged largely in the past decade, with the earliest dating to 1973 (1). Most major insurers and all major reinsurers and insurance brokers have engaged to varying degrees, collectively representing \$2 trillion (44%) of industry revenues and 2.5 million employees. See key to activity types (**A**), next page. (**B**) Countries conducting more than 5% of all activities are shaded individually. (**C**) These activities are conducted by several types of entities, including intermediaries and modelers that provide services to insurance companies.

#### Key to Fig. S1A.

- Commitment to a comprehensive response: defined by participation in the ClimateWise group, UNEP Finance Initiative, and/or Kyoto Statement of the Geneva Association. The terms of the associated agreements are characterized by a commitment to addressing climate change that stretches across the insurance enterprise, from products to investment to corporate governance. Participating companies are listed in table S1. Participation signals a systematic (rather than piecemeal) approach, coupled with a willingness to make that commitment public. In the case of ClimateWise, participants also agree to annual reporting and independent audits of compliance.
- **Engaging in climate science and communications:** defined by the funding or conduct of research on climate change, and the presentation of climate science to stakeholders. Includes analyses of historical data, forward-looking modeling, field-based research, and integrated assessments.
- **Promoting loss prevention & adaptation:** defined by customer-focused activities or inducements to advance the state of the art in weather- and climate-related disaster resilience generally, and climate change adaptation in particular.
- Aligning terms & conditions with risk-reducing behavior: defined by activities that simultaneously reduce the risk of insured losses while contributing to climate change mitigation. A prominent example is mileage-based insurance, which provides discounted premiums for reduced driving to lower the probability of roadway accidents as well as emissions of greenhouse gases from vehicles.
- **Crafting innovative insurance products:** defined by insurance contracts and provisions that remove barriers to adoption of climate change mitigation practices (e.g., energy efficiency or renewable energy) on the part of insurance customers, often proactively incentivizing better practices (e.g. by differentiating premiums for hybrid vehicles or green buildings). Includes new products that fill coverage gaps, e.g., microinsurance for weather-related hazards in developing countries.
- **Providing technical services:** defined by engineering or financial services offered to customers to identify and manage risks associated with climate change responses or otherwise assist in the implementation of improved practices. Examples include energy audits, carbon-footprint accounting, and adaptation costbenefit assessments.
- Offering carbon risk-management or offsets: defined by products that assist customers in managing risks associated with carbon-reducing projects, including risks of associated financial transactions such as carbon trading. In some cases, insurers couple emission offsets with their core products, e.g., vehicle emissions offsets with auto insurance.
- **Financing customer projects:** defined by insurers offering debt financing to customers or other entities for climate change mitigation or adaptation projects.
- **Investing in climate change mitigation:** defined by direct investment in climate change mitigation projects, e.g., an equity stake in a wind power development or a company manufacturing an energy-efficient technology. Also includes investments in funds by using selective environmental screening processes that incorporate climate-change factors. In some cases, insurers are disinvesting in companies with risky environmental practices.
- **Building awareness and participating in public policy:** defined by specific activities to improve understanding of climate change among policy-makers. Examples include participation in climate-change negotiations, engagement in efforts to reform land-use planning to proactively anticipate sealevel rise, or promotion of building codes that improve disaster resilience or energy efficiency.
- **Leading by example: In-house carbon management:** defined by specific activities to reduce the carbon footprint of insurers' internal operations (buildings, business travel, computing, and supply chains). For inclusion, a threshold level of activity is required, beyond highly routine activities such as "using energy-efficient light bulbs."
- **Disclosing climate risks:** defined by responding to climate-risk disclosure requests from the CDP, F&C, or the U.S. Securities and Exchange Commission (SEC).

### Mangrove Reforestation by Tokio Marine & Nichido Insurance Company

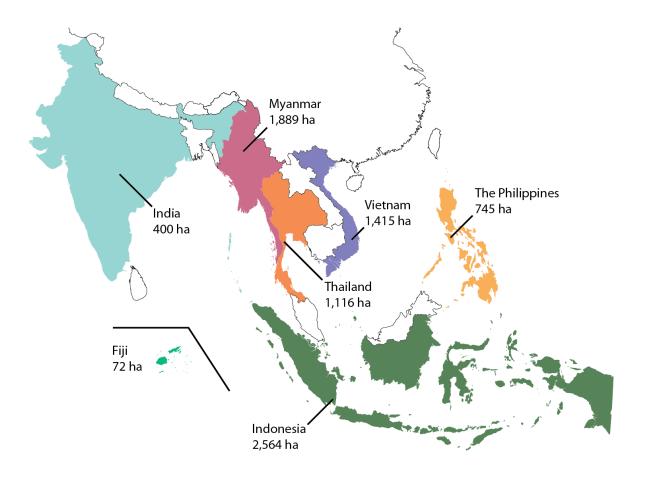


Fig S2.

Tokio Marine & Nichido, Japan's largest insurer, embarked on a mangrove reforestation project in 1999. The project scale is approaching its target of just over 8,200 ha (20,265 acres) across seven countries. The company cites carbon sequestration (contributing to its own carbon neutrality since 2008) and enhanced resilience to storm damages as joint mitigation-adaptation benefits of the project (table S4, row 1).

# **Carbon Disclosure Project Response Rates**

Insurance Companies: 2003-2011

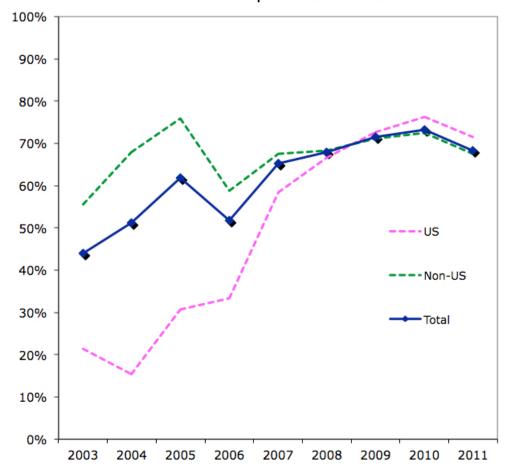


Fig. S3.
Institutional investors participating in the Carbon Disclosure Project (CDP) seek to manage financial risks when climate change exposures among the companies in which they invest are insufficiently disclosed or when lack of care threatens financial or reputational losses to the company. Claims can trigger Directors and Officers insurance policies or other classes of liability insurance (15). As of 2011, the CDP represented 655 institutional investor members with \$78 trillion in assets. A total of 93 insurers responded to the CDP over the past decade. Response rates for U.S. firms once lagged far behind those from other countries, but have recently surpassed non-U.S. response rates at around 70%. See table S8 for company-specific details. Separate from the CDP, insurance regulators crafted a national disclosure process tailored for U.S. companies, which subsequently became mandatory in California, New York, Pennsylvania, and Washington.

## **Insurer Investments in Climate Change Mitigation**

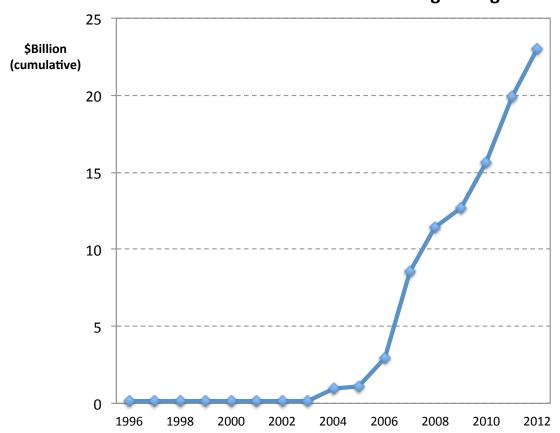


Fig. S4.

Insurer funding of climate change mitigation includes large direct investments in emissions-reduction technologies, businesses, and securities as well as financing for specific projects. The figure aggregates 32 investments by 22 companies for which data are publicly available (inflation-corrected to 2011 values). Twenty-two additional investments are known, but the amounts are not published. See table S9 for company-by-company details. Amounts reflect initial investments and do not include change in value over time. Although tabulated in the database, this figure does not include \$5 billion invested in diversified "socially-responsible" funds that have an broad environmental component rather than a climate change specialization, disinvestment in companies that exacerbate the climate change problem, or investment in reducing insurers' own carbon footprint.

## **Carbon-neutral Insurers**

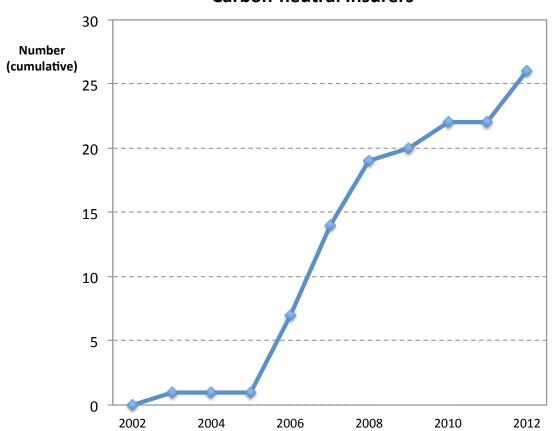


Fig. S5.

Insurers engaged in climate-change activities tend to also focus on reducing or offsetting their own emissions as a form of leadership-by-example. As shown in the figure, 26 companies have pursued this to the point of carbon neutrality. Details and timelines are listed in table S10, along with indications (where available) of how the reductions were attained, particularly the degree to which this was accomplished with in-house energy management versus the acquisition of carbon offsets in the marketplace.

- Table S1. Public commitment to comprehensive, enterprise-wide response to climate risk
- Table S2. Insurer climate change science and loss data analysis activities
- Table S3. Insurer climate change adaptation projects
- Table S4. Insurer recognition of emissions-reduction and loss-prevention cobenefits
- Table S5. Illustrative climate change–related insurance products, services, and policy
- Table S6. Climate engineering: strategies, effectiveness, cost, risks, cobenefits
- Table S7. Climate engineering: comparative hazards and vulnerabilities
- Table S8. Insurer responses to the CDP surveys: 2003–2011
- Table S9. Selected insurer investments in climate change mitigation (cumulative)
- Table S10. Carbon-neutral insurers

If links are not active in PDF, all are reachable here:

https://docs.google.com/spreadsheet/ccc?key=0Als8219SGDIjdDFiVnJvckpITTU4QVBmUDdGTWxxbEE#gid=8

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